

# Primary Selection

## Charged Tracks:

- At least 3 positive and 3 negative charged tracks;
- Polar angle of each track in MDC:  $|\cos \theta| < 0.93$ ;

## PID:

- PID used for separate proton and  $\pi$ ;
- p:  $\text{prob}(p) > \text{prob}(\pi, K)$ ;  $\pi$ :  $\text{prob}(\pi) > \text{prob}(p, K)$ ;

## $\Lambda\bar{\Lambda}$ reconstruction:

- Looping all pairs of proton and  $\pi$  to pass vertex fit and second vertex fit, and saved as  $\Lambda\bar{\Lambda}$  candidate ;
- One pair of  $\Lambda\bar{\Lambda}$  with the minimal value  $(M_{p\pi^-} - M_{\Lambda})^2 + (M_{\bar{p}\pi^+} - M_{\bar{\Lambda}})^2$  kept;

## $\pi^+ \pi^-$ reconstruction:

- $|V_z| < 10\text{cm}, |V_{xy}| < 1\text{cm}$ ;
- Vertex fit to the pair of  $\pi^+ \pi^-$ ;
- One pair of  $\pi^+ \pi^-$  with minimal vertex fit  $\chi^2$  kept;

# Primary Selection

## Good Shower:

- Shower energy:  $E_\gamma > 25\text{MeV}$  for the barrel region ( $|\cos \theta| < 0.8$ ),  $E_\gamma > 50\text{MeV}$  for the endcap region ( $0.86 < |\cos \theta| < 0.92$ );
- Flight time in EMC (0,700)ns;
- Opening angle between shower and the nearest charged track  $> 10^\circ$ ;
- Number of good shower more than one for  $\eta' \rightarrow \gamma\pi^+\pi^-$ , and than two for  $\eta' \rightarrow \eta\pi^+\pi^-$ ;

## Kinematic fit:

- 4C for  $\eta' \rightarrow \gamma\pi^+\pi^-$ ;
- 5C for  $\eta' \rightarrow \eta\pi^+\pi^-$ , that 1C for  $\eta \rightarrow \gamma\gamma$ ;

$$\eta' \rightarrow \gamma \pi^+ \pi^-$$

$$\text{Cut: } \chi^2 < 30;$$

$$|M_{\Lambda/\bar{\Lambda}} - 1.115683| < 6 \text{ MeV}$$

$$M_{\gamma \pi^+ \pi^-} \in (0.94, 0.97) \text{ MeV}/c^2$$

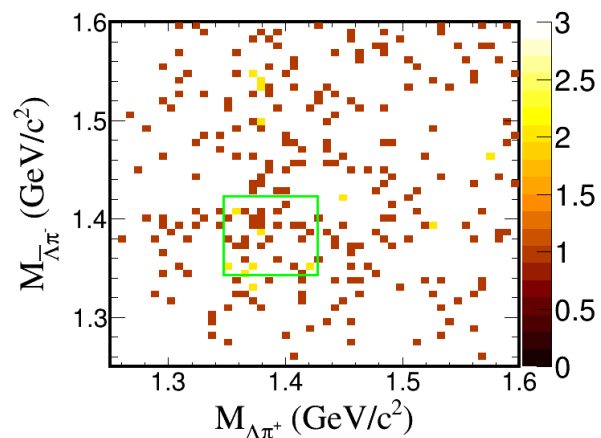
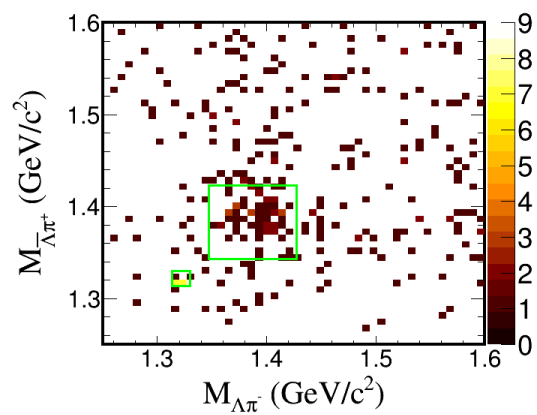
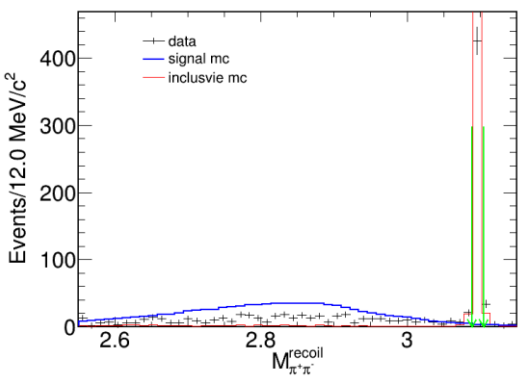
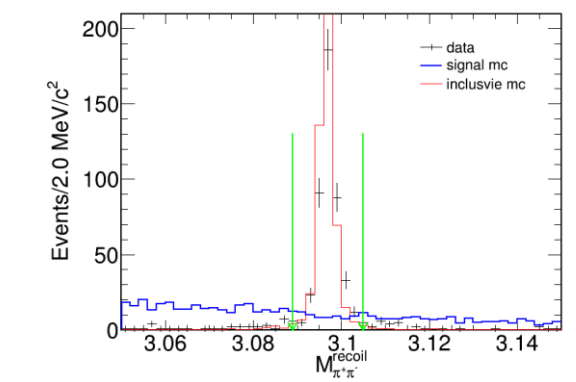
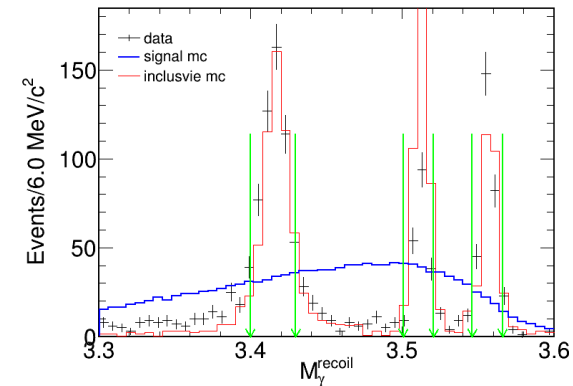
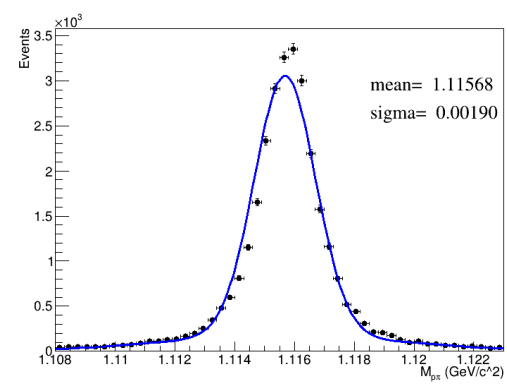
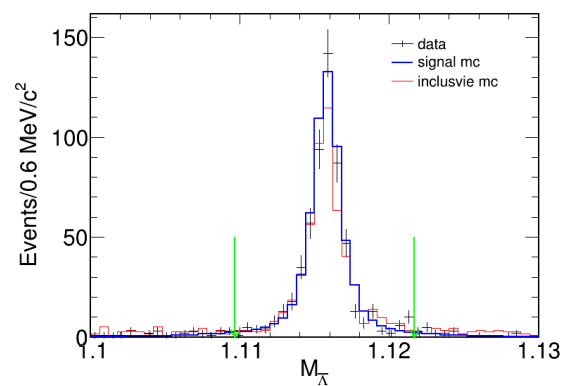
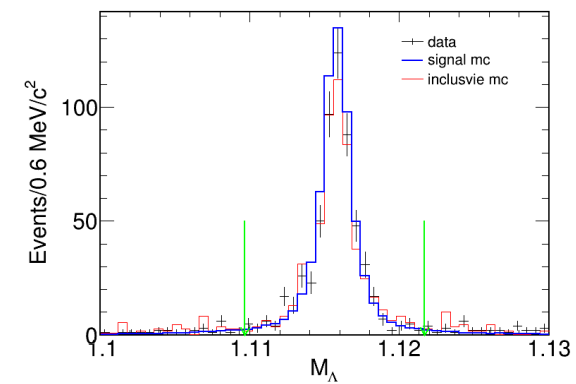
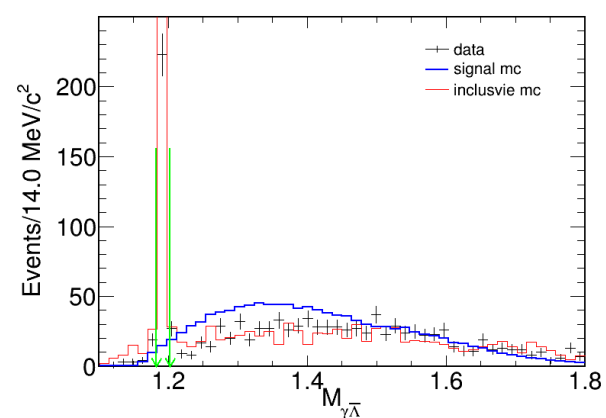
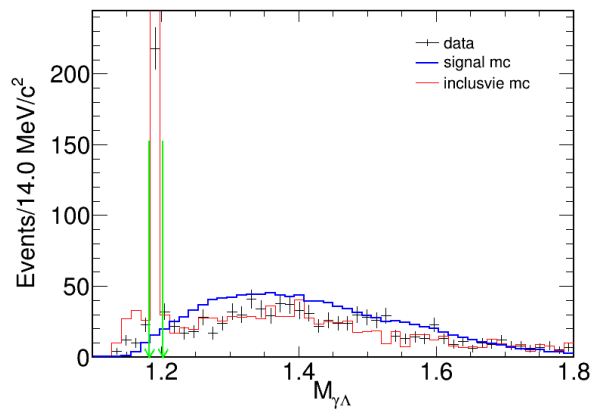
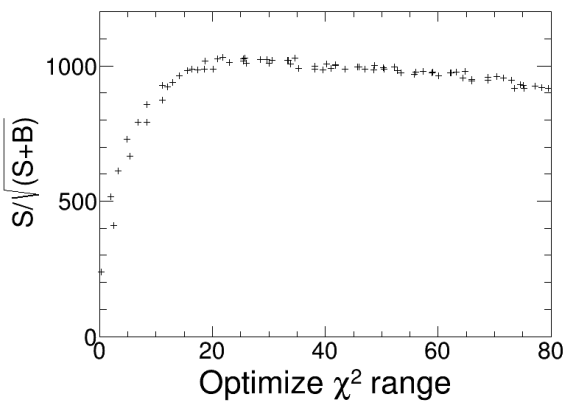
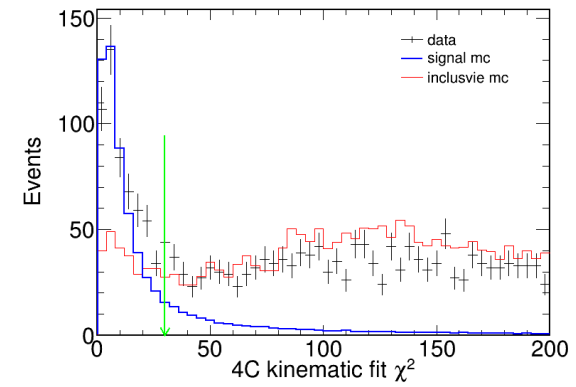
$$|M_{\gamma \Lambda(\bar{\Lambda})} - 1.193 \text{ GeV}| > 10 \text{ MeV}/c^2$$

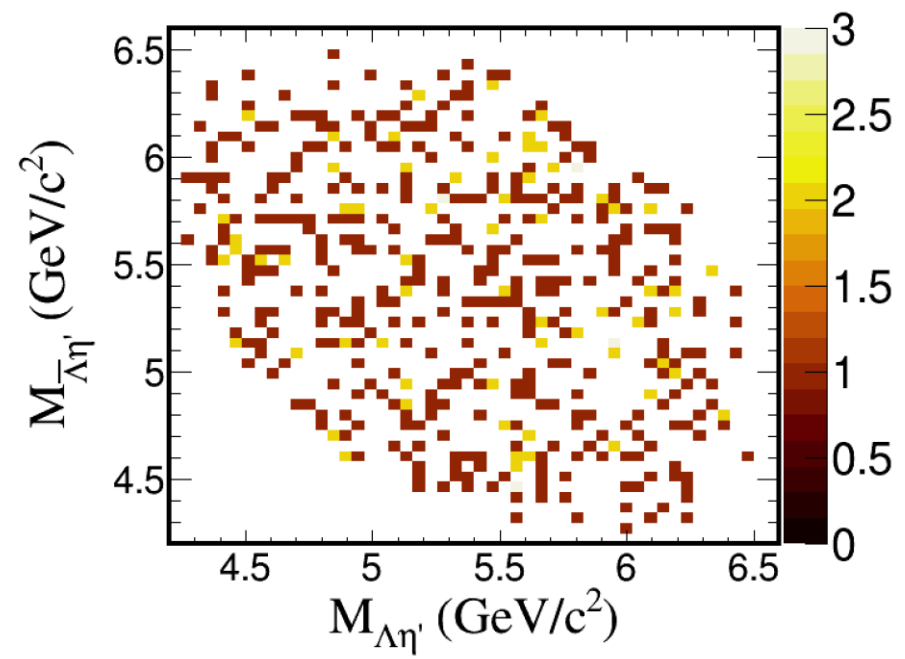
$$|M_{2\pi}^{recoil} - 3.097| > 8 \text{ MeV};$$

$$|M_{\gamma}^{recoil} - \chi_{c0}| > 18 \text{ MeV}/c^2, |M_{\gamma}^{recoil} - \chi_{c1}| > 12 \text{ MeV}/c^2, |M_{\gamma}^{recoil} - \chi_{c2}| > 12 \text{ MeV}/c^2$$

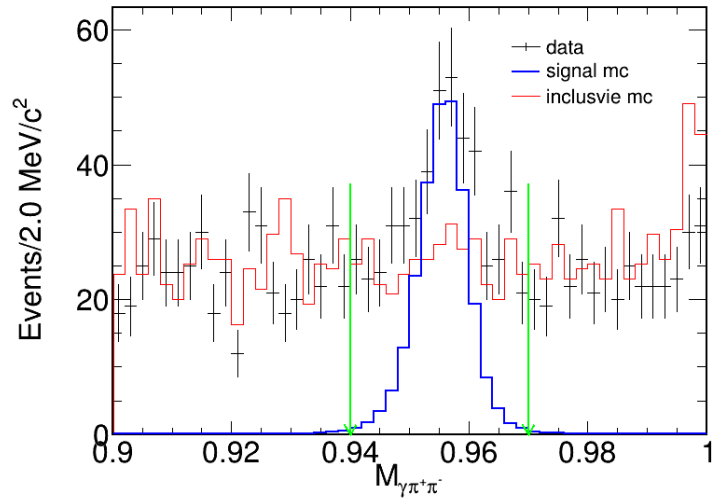
$$|M_{\Lambda \pi^- (\bar{\Lambda} \pi^+)} - M_{\Xi^-}| > 8 \text{ MeV}$$

$$\text{Veto } \Sigma(1385) \text{ region } |M_{\Lambda \pi} - M_{\Sigma^*}^{PDG}| > 40 \text{ MeV};$$

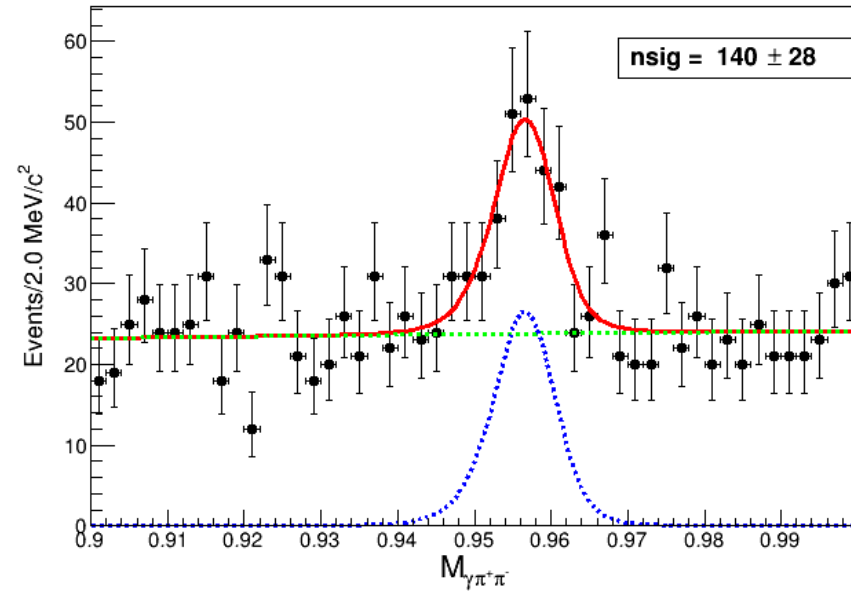




rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$\psi' \rightarrow \pi^+ \pi^- J/\psi, J/\psi \rightarrow \Lambda \bar{\Lambda} \gamma, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	1	159	159
2	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow \pi^+ \Lambda \bar{\Sigma}^{*-}, \Lambda \rightarrow \pi^- p, \bar{\Sigma}^{*-} \rightarrow \pi^- \bar{\Lambda}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	0	31	190
3	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow \pi^- \bar{\Sigma}^{*+} \Lambda, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	12	27	217
4	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow \pi^+ \Sigma^{*-} \bar{\Lambda}, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	3	26	243
5	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow \pi^- \bar{\Lambda} \Sigma^{*+}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	9	24	267
6	$\psi' \rightarrow \eta' \Lambda \bar{\Lambda}, \eta' \rightarrow \pi^+ \pi^- \gamma^F, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma^F$	17	13	280
7	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow K^{*+} \bar{p} \Lambda, K^{*+} \rightarrow \pi^+ K^0, \Lambda \rightarrow \pi^- p, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	43	13	293
8	$\psi' \rightarrow \pi^- \bar{\Sigma}^{*+} \Lambda \gamma^f, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma^f$	45	9	302
9	$\psi' \rightarrow \pi^+ \Lambda \bar{\Sigma}^{*-} \gamma^f, \Lambda \rightarrow \pi^- p, \bar{\Sigma}^{*-} \rightarrow \pi^- \bar{\Lambda}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma^f$	31	7	309
10	$\psi' \rightarrow \chi_{c2} \gamma, \chi_{c2} \rightarrow \pi^- \bar{\Lambda} \Sigma^{*+}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	32	7	316
11	$\psi' \rightarrow \chi_{c2} \gamma, \chi_{c2} \rightarrow \pi^- \bar{\Sigma}^{*+} \Lambda, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	21	7	323
12	$\psi' \rightarrow \chi_{c1} \gamma, \chi_{c1} \rightarrow \pi^- \bar{\Lambda} \Sigma^{*+}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	22	7	330
13	$\psi' \rightarrow \pi^- \bar{\Lambda} \Sigma^{*+} \gamma^f, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma^f$	8	6	336
14	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow K^{*-} p \bar{\Lambda}, K^{*-} \rightarrow \pi^- \bar{K}^0, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	35	6	342
15	$\psi' \rightarrow \chi_{c2} \gamma, \chi_{c2} \rightarrow \pi^+ \Lambda \bar{\Sigma}^{*-}, \Lambda \rightarrow \pi^- p, \bar{\Sigma}^{*-} \rightarrow \pi^- \bar{\Lambda}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	6	6	348
16	$\psi' \rightarrow \pi^- \bar{\Lambda} \Sigma^{*+}, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p}$	18	6	354
17	$\psi' \rightarrow \pi^- \bar{\Sigma}^{*+} \Sigma^0, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Sigma^0 \rightarrow \Lambda \gamma, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	50	6	360
18	$\psi' \rightarrow \pi^+ \Sigma^{*-} \bar{\Lambda} \gamma^f, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma^f$	11	5	365
19	$\psi' \rightarrow \chi_{c1} \gamma, \chi_{c1} \rightarrow \pi^- \bar{\Sigma}^{*+} \Lambda, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	47	5	370
20	$\psi' \rightarrow \chi_{c0} \gamma, \chi_{c0} \rightarrow \rho^0 \Lambda \bar{\Lambda}, \rho^0 \rightarrow \pi^+ \pi^-, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma$	28	5	375



$$PDF(\eta' \rightarrow \gamma\pi^+\pi^-) = MCshape \otimes \text{gauss} + 2^{\text{nd}} - \text{chebychevpolynomial}$$



$$BR = 6.84 \pm 1.37 \times 10^{-6}$$

# Cut flow ( $\eta' \rightarrow \gamma\pi^+\pi^-$ )

Criteria	Efficiency(%)
Ncharge>6	42.59
PID	30.01
$\Lambda/\bar{\Lambda}$ reconstrain	29.06
$\pi^+\pi^-$ vertex fit	23.57
$N_\gamma > 1$	23.44
Pass 4c	15.30
$\chi^2 < 30$	10.45
$ M_{p\pi} - M_{\Lambda(\bar{\Lambda})}  < 5MeV$	9.31
$M_{\gamma\pi^+\pi^-} \in (0.9, 1.0)$	9.29
$ M_{\gamma\Lambda(\bar{\Lambda})} - M_{\Sigma^0}  > 10MeV$	8.90
$ M_{\pi^+\pi^-}^{recoil} - M_{Jpsi}  > 8MeV$	8.85
cut $M_\gamma^{recoil}$	6.57
Cut $\Sigma(1385)\&\Xi^-$	6.29



# Continuum data

$$\begin{aligned} & \frac{L_{3686}}{L_{3773}} \times \frac{S_{3773}}{S_{3686}} \times N_{3773} \\ &= 0.065 \times 21 \\ &= 1.37 \end{aligned}$$

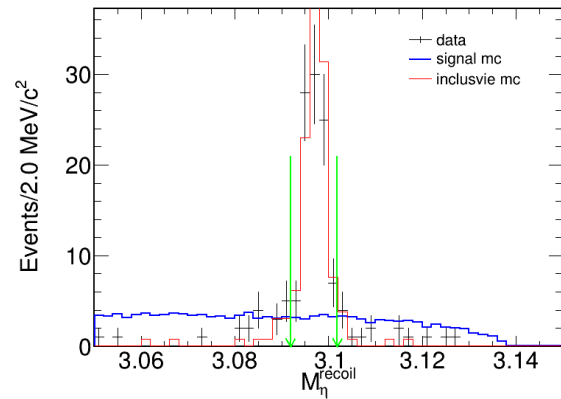
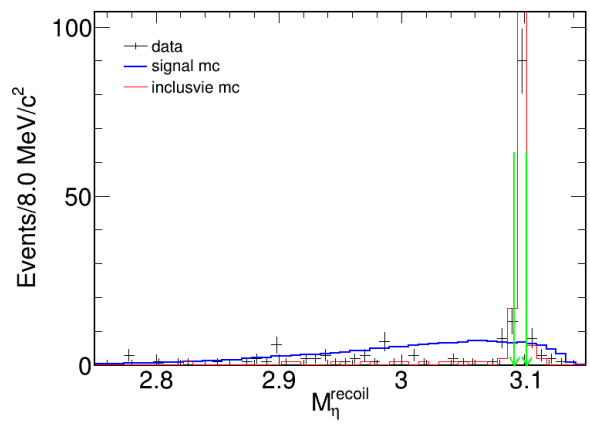
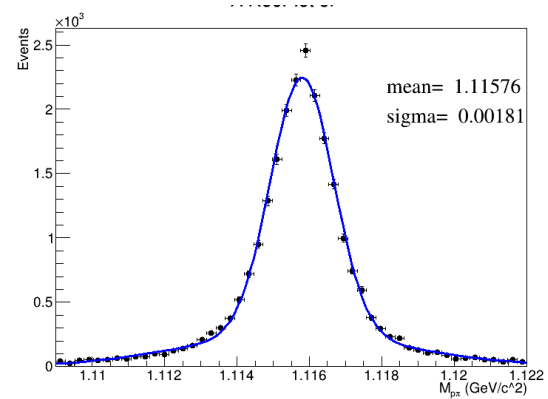
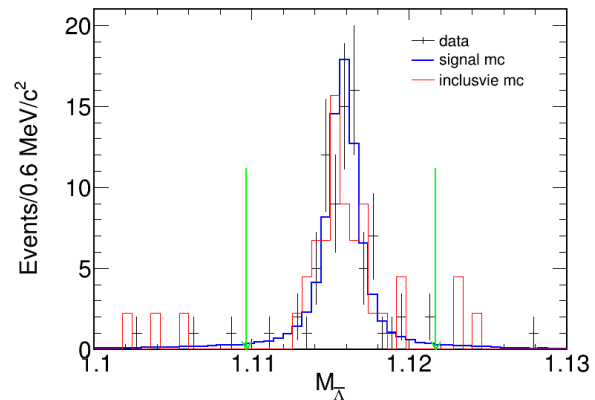
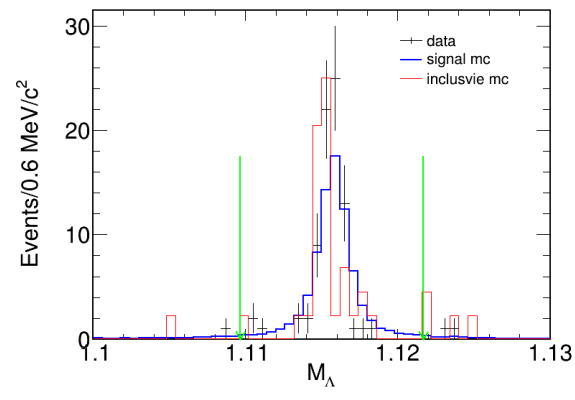
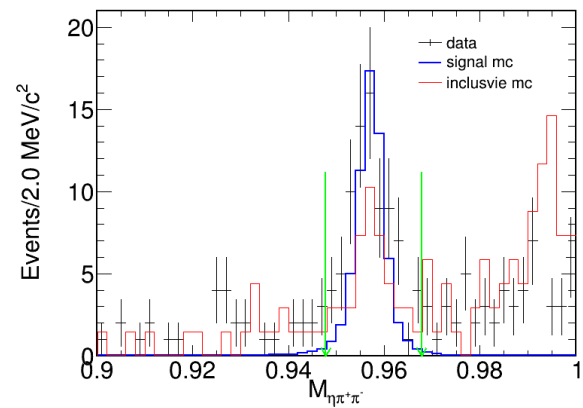
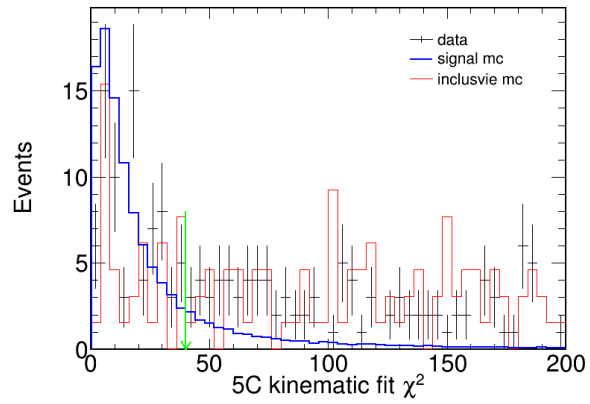
$$\eta' \rightarrow \eta\pi^+\pi^-$$

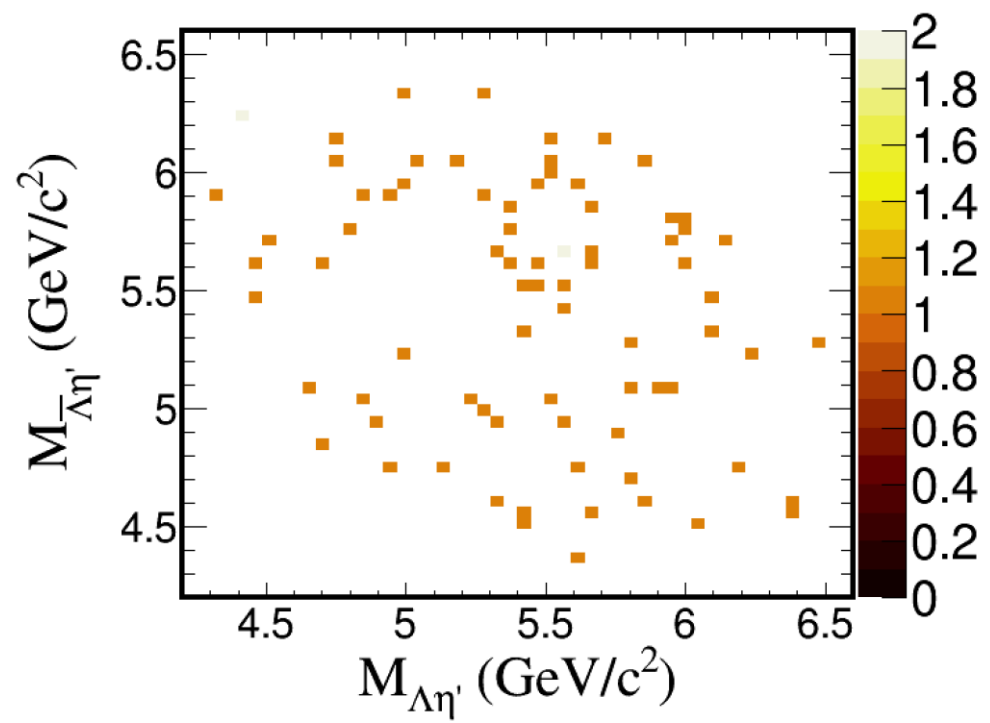
$$\text{Cut: } \chi^2 < 40;$$

$$|M_{p\pi} - M_{\Lambda(\bar{\Lambda})}| < 6\text{MeV}/c^2;$$

$$|M_{\eta\pi^+\pi^-} - M_{\eta'}| < 0.01\text{GeV}/c^2;$$

$$|M_{recoil}^{\eta} - M_{J/\psi}| > 5\text{MeV}/c^2;$$





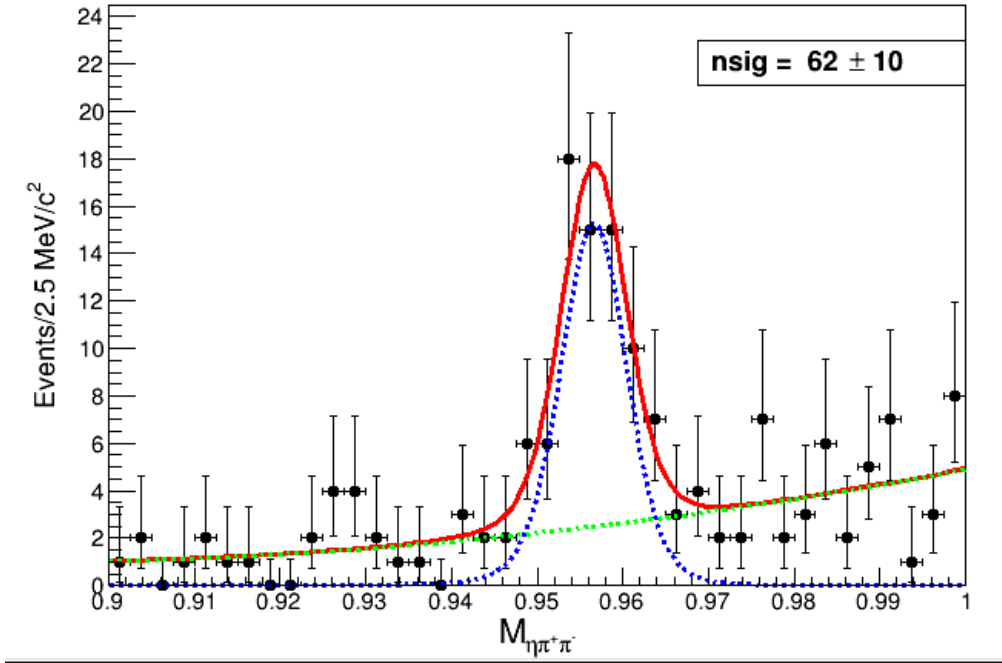
# Continuum data

$$\frac{L_{3686}}{L_{3773}} \times \frac{S_{3773}}{S_{3686}} \times N_{3773}$$
$$= 0.065 \times 2$$

rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$\psi' \rightarrow \eta' \Lambda \bar{\Lambda}, \eta' \rightarrow \pi^+ \pi^- \eta, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \eta \rightarrow \gamma\gamma$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	0	13	13
2	$\psi' \rightarrow \eta J/\psi, \eta \rightarrow \gamma\gamma, J/\psi \rightarrow \pi^+ \pi^- \Lambda \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	3	4	17
3	$\psi' \rightarrow \eta J/\psi, \eta \rightarrow \gamma\gamma, J/\psi \rightarrow \Xi^+ \Xi^-, \Xi^+ \rightarrow \pi^+ \bar{\Lambda}, \Xi^- \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	5	3	20
4	$\psi' \rightarrow \eta \bar{\Sigma}^{*+} \Sigma^{*-}, \eta \rightarrow \gamma\gamma, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	1	2	22
5	$\psi' \rightarrow \eta J/\psi, \eta \rightarrow \gamma\gamma, J/\psi \rightarrow \pi^+ \Sigma^{*-} \bar{\Lambda}, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	6	2	24
6	$\psi' \rightarrow \eta J/\psi, \eta \rightarrow \gamma\gamma, J/\psi \rightarrow \bar{\Sigma}^{*+} \Sigma^{*-}, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	8	2	26
7	$\psi' \rightarrow \pi^0 \pi^0 J/\psi, J/\psi \rightarrow \Lambda \bar{\Lambda} \gamma, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^0 \pi^0 \pi^+ \pi^- p \bar{p} \gamma$	4	1	27
8	$\psi' \rightarrow \eta \Sigma^{*+} \bar{\Sigma}^{*-}, \eta \rightarrow \gamma\gamma, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \bar{\Sigma}^{*-} \rightarrow \pi^- \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	7	1	28
9	$\psi' \rightarrow \chi_{c1} \gamma, \chi_{c1} \rightarrow J/\psi \gamma, J/\psi \rightarrow \bar{\Sigma}^{*+} \Sigma^{*-}, \bar{\Sigma}^{*+} \rightarrow \pi^+ \bar{\Lambda}, \Sigma^{*-} \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	2	1	29
10	$\psi' \rightarrow \chi_{c1} \gamma, \chi_{c1} \rightarrow J/\psi \gamma, J/\psi \rightarrow \Xi^+ \Xi^-, \Xi^+ \rightarrow \pi^+ \bar{\Lambda}, \Xi^- \rightarrow \pi^- \Lambda, \bar{\Lambda} \rightarrow \pi^+ \bar{p}, \Lambda \rightarrow \pi^- p$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	9	1	30
11	$\psi' \rightarrow \eta J/\psi, \eta \rightarrow \gamma\gamma, J/\psi \rightarrow \Sigma^{*+} \Sigma^{*-}, \Sigma^{*+} \rightarrow \pi^+ \Lambda, \Sigma^{*-} \rightarrow \pi^- \bar{\Lambda}, \Lambda \rightarrow \pi^- p, \bar{\Lambda} \rightarrow \pi^+ \bar{p}$	$\pi^+ \pi^+ \pi^- \pi^- p \bar{p} \gamma \gamma$	10	1	31

# Cut flow( $\eta' \rightarrow \eta\pi^+\pi^-$ )

Criteria	Efficiency(%)
Ncharge>6	37.41
PID	24.97
$\Lambda/\bar{\Lambda}$ reconstrain	24.08
$\pi^+\pi^-$ vertex fit	16.39
$N_\gamma > 2$	15.87
Pass 5c	7.74
$\chi^2 < 40$	5.63
$ M_{p\pi} - M_{\Lambda(\bar{\Lambda})}  < 5MeV$	4.96
$M_{\eta\pi^+\pi^-} \in (0.9,1.0)GeV/c^2$	4.92
$ M_{eta}^{recoil} - M_{Jpsi}  > 5MeV$	4.70



$$\text{BR} = 7.15 \pm 1.15 \times 10^{-6}$$